THE CITY OF SAN DIEGO

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Water Purification Demonstration Project

Project Report (Final Draft)

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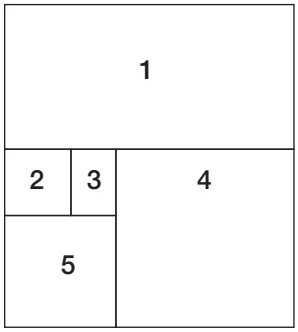

1. The Advanced Water Purification Facility
2. Ultraviolet Light/Advanced Oxidation equipment
3. Reverse Osmosis canisters
4. Microfiltration and Ultrafiltration systems
5. San Vicente Reservoir

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Figures and Tables

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Terms and Abbreviations

AF	Acre-feet
AFY	Acre-feet per year
AWP Facility	Advanced Water Purification Facility – the existing demonstration-scale facility constructed and operated for the Water Purification Demonstration Project
Basin Plan	Water Quality Control Plan for the San Diego Basin
Bureau of Reclamation	United States Bureau of Reclamation
CDPH	California Department of Public Health
CEC	Constituent of emerging concern
CEQA	California Environmental Quality Act
City	City of San Diego
City Council	San Diego City Council
CTR	California Toxics Rule
Demonstration Project	Water Purification Demonstration Project
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EPA	United States Environmental Protection Agency
Full-scale AWP facility	Full-scale AWP facility that would be implemented for future full-scale reservoir augmentation
GIS	Geographic Information Systems
IAP	Independent Advisory Panel
IROC	Independent Rates Oversight Committee
kWh	Kilowatt hours
LRWRP	Long-Range Water Resources Plan
MCL	Maximum Contaminant Level
mgd	Million gallons per day
NDMA	N-Nitrosodimethylamine
North City	North City Water Reclamation Plant
NR&C	Natural Resources & Culture Committee
NPDES	National Pollutant Discharge Elimination System
NWRI	National Water Research Institute
O&M	Operations and maintenance
Orange County GWRS	Orange County Groundwater Replenishment System
Point Loma	Point Loma Wastewater Treatment Plant

Regional Board	San Diego Regional Water Quality Control Board
RWS	City of San Diego Recycled Water Study, 2012
SR-52	State Route 52
State Board	State Water Resources Control Board
Water Authority	San Diego County Water Authority
WDR	Waste Discharge Requirements

Glossary of Terms

1,4-dioxane	A solvent used in industrial and commercial applications. The California Department of Public Health uses 1,4-dioxane as an indicator compound to assess the performance of advanced oxidation since it is difficult to remove from water. The ability of a purification process to remove 1,4-dioxane indicates to the California Department of Public Health that the purification process provides a robust barrier to a wide array of chemicals.
Acre-feet (AF)	A term commonly used in the water industry to measure large quantities of water. An acre-foot is defined as the amount of water required to cover one acre to a depth of one foot. An acre-foot is equivalent to 325,851 gallons and is considered enough water to meet the needs of two families of four with a house and a yard for one year.
Advanced oxidation	A set of chemical treatment processes designed to destroy organic material by breaking down its molecular structure. The advanced oxidation process used at the Advanced Water Purification Facility employs ultraviolet light and hydrogen peroxide, which break down organic molecules into natural elements, such as carbon, hydrogen, and nitrogen.
Advanced Water Purification Facility	The one-mgd demonstration-scale facility located at the North City Water Reclamation Plant. Generally abbreviated as the AWP Facility. The facility is considered "advanced" because of the high level of treatment using reverse osmosis and advanced oxidation. The AWP Facility was one element of the multi-faceted Demonstration Project.
Augmentation of water supply	The process of adding purified water to an existing raw or untreated water supply such as a reservoir, lake, river, wetland, and/or groundwater basin where it will blend with raw water supplies.
Beneficial reuse	The use of recycled water for purposes that contribute to the economy or environment of a community, such as landscape irrigation and industrial purposes.
Beneficial use	Specific designated water uses such as municipal, recreation, and agricultural, which are provided water quality protections to allow those uses to continue to occur in the future.
Blending	Mixing or combining one water source with another, such as combining purified water with imported water sources.

Brackish water	Water that has a higher salt content than fresh water, but not as high as seawater. Usually, the salts must be removed or reduced before the water is usable.
California Department of Public Health (CDPH)	The state agency responsible for public health in California. It is a subdivision of the California Health and Human Services Agency. One of its functions is to develop and enforce drinking water quality standards and regulations for public water systems.
Clean Water Act	The federal law passed in 1977 that establishes how the United States will restore and maintain the chemical, physical, and biological integrity of the country's waters, including oceans, lakes, streams and rivers, groundwater, and wetlands.
Conductivity	The ability to conduct or transmit electricity. Conductivity of water increases with the concentration of dissolved ions, so measuring conductivity provides a measure of the concentration of dissolved ions in water.
Constituent	A dissolved chemical element or compound, or a suspended material that is carried in the water.
Constituents of emerging concern	Unregulated contaminants, including commonly used pharmaceuticals, personal care products, flame retardants, and unregulated pesticides.
Contaminant	An organic or inorganic substance found in water. Some contaminants cause adverse health effects in humans and, therefore, are regulated in drinking water (see Maximum Contaminant Level). Not all contaminants are unsafe.
Conventional wastewater treatment	A combination of treatment steps that stabilizes and removes solids and organic material from wastewater.
Demonstration Project	See Water Purification Demonstration Project
Disinfection	The removal, inactivation, or destruction of microorganisms present in a water supply that may be harmful to humans. Commonly used disinfectants include chlorine and its derivatives, ultraviolet light, and ozone. Chlorine and its derivatives can also be used to provide residual disinfection that protects the water as it goes through the pipes to homes and businesses.
Disinfection byproduct	Chemicals formed during water treatment as a byproduct of reactions between natural organic matter in the water and an added disinfectant. In drinking water, some disinfection byproducts may have potential health concerns.

Drinking water	Water that meets federal drinking water standards as well as state and local water quality standards so that it is safe for human consumption. Water treatment facilities that produce drinking water require a state permit. Also referred to as potable or treated water.
Drinking water treatment plant	In the San Diego region, drinking water treatment plants draw unfiltered water from reservoirs and use a four-step process of coagulation, settling, filtration, and disinfection to produce water that is safe to drink (see drinking water).
Drought	A defined period of time when rainfall and runoff in a geographic area are much less than average.
Environmental buffer	A water body such as a groundwater basin or a surface water reservoir that provides additional dilution and retention of purified water prior to its use as drinking water.
Environmental Impact Statement/Environmental Impact Report	Detailed analysis of impacts of a project on all aspects of the natural and human environment. An Environmental Impact Statement is required by the federal National Environmental Policy Act for federal permitting or use of federal funds. An Environmental Impact Report is required by the California Environmental Quality Act for local projects.
Epilimnion	The top-most layer of warm water present within a stratified water reservoir (see stratification).
Filtration	A process that separates small particles from water by using a porous barrier to trap the particles while allowing the water to pass through.
Groundwater	Water beneath the earth's surface that supplies wells and natural springs. A groundwater basin is any underground area that contains and can store water.
Groundwater Replenishment Reuse Draft Regulation (California Department of Public Health Groundwater Recharge Criteria)	Draft regulation released by the California Department of Public Health in 2011, which reflects the California Department of Public Health Drinking Water Program's proposed regulation for replenishing groundwater with purified water.
Full-scale reservoir augmentation project	A potential third phase of the City's Water Reuse Program, which would include implementation of a full-scale reservoir augmentation project at San Vicente Reservoir (see reservoir augmentation).
Hydrogen peroxide	Chemical added in the ultraviolet disinfection/advanced oxidation step of the advanced water purification process.
Hypolimnion	The bottom-most layer of cool water present within a stratified water reservoir (see stratification).

Imported water	A water source that originates in one hydrologic region and is transferred to another hydrologic region. In San Diego's case, water is imported from Northern California or the Colorado River and travels to San Diego in large above-ground aqueducts or underground pipelines.
Independent Advisory Panel (IAP)	An independent panel of experts convened to provide expert peer review of the technical, scientific, and regulatory aspects of the Demonstration Project.
Indicator compounds or indicator organisms	A common method to evaluate water or wastewater quality using representative chemicals or organisms that are characteristic of a larger group of related chemicals or organisms. Coliform bacteria are common indicator organisms, and trihalomethanes, benzene, 1,4-dioxane, and NDMA are examples of indicator compounds.
Indirect potable reuse	An industry term referring to projects that augment groundwater and surface waters with purified water. This term was originally used to distinguish between direct potable reuse, which is the introduction of purified water into the drinking water system without an intermediate environmental buffer, and systems that did incorporate an environmental buffer. Potable reuse is a general term used to refer to both direct and indirect purified water projects.
Local limits	Local limits are wastewater limitations that apply to commercial and industrial facilities discharging wastewater to a municipal public system. Local limits control the pollutants in wastewater discharges.
Maximum Contaminant Level (MCL)	The highest allowable amount of a contaminant in drinking water, established by the United States Environmental Protection Agency.
Membrane filtration	A type of filtration used to separate particles from water. Membrane filters are characterized by the size of the openings (pores), which are ranked from the largest to the smallest pore size: microfiltration, ultrafiltration, nanofiltration and reverse osmosis.
Microfiltration	A low-pressure membrane filtration process where tiny, hollow, straw-like membranes separate small suspended particles, bacteria and other materials from water. Microfiltration provides efficient preparation of water for reverse osmosis and is used to process food, fruit juices and sodas; and to sterilize medicines that cannot be heated.
Million gallons per day	This term is used to describe the flow of water treated and distributed from a treatment plant each day.

N-nitrosodimethylamine (NDMA)	N-nitrosodimethylamine is a chemical that is found in a variety of natural and man-made sources and can be formed during wastewater treatment. It is used by the California Department of Public Health as an indicator compound to assess the performance of advanced oxidation since it is difficult to remove from water. The ability of a purification process to achieve removal indicates to the California Department of Public Health that the process provides a robust barrier to a wide array of chemicals.
National Pollutant Discharge Elimination System (NPDES)	A federal permit authorized by the Clean Water Act, Title IV, which is required for discharge of pollutants to waters of the United States, and includes any discharge to lakes, streams, rivers, bays, the ocean, wetlands, storm sewer, or tributary to any surface water body.
Non-potable water	Water that is not suitable for drinking because it has not been treated to drinking water standards (see drinking water). Includes recycled water as well as raw or untreated water.
North City Water Reclamation Plant (North City)	Wastewater treatment plant that produces recycled water through a combination of conventional wastewater treatment and tertiary treatment (see conventional wastewater treatment and tertiary treatment).
Orange County Groundwater Replenishment System (GWRS)	A project that employs water purification processes similar to those tested at the AWP Facility, which has been operational since 2008. This project provides a model for the City's potential reservoir augmentation project in that it uses similar water purification technology and is permitted under a similar regulatory framework.
Oxidation	A treatment step used in disinfection, in which oxygen or ozone is added to water to produce a chemical reaction that removes potentially harmful substances.
Pathogens	Disease-causing organisms. The general groupings of pathogens are viruses, bacteria, protozoa, and fungi.
Pipeline system	Pipeline system, including pump station and reservoir inlet structure, which would convey purified water from North City to San Vicente Reservoir. Also referred to as purified water pipeline system.
Point Loma Wastewater Treatment Plant (Point Loma)	Advanced primary wastewater treatment plant that discharges treated wastewater to the Pacific Ocean.
Pretreatment	The treatment of wastewater near its source to remove harmful pollutants before being discharged to a sewer system.
Primary drinking water standards	Legally enforceable federal and state standards that must be met by public water systems. Primary drinking water standards protect public health by limiting the levels of contaminants in drinking water.

Purified water	Water that starts out as wastewater from homes or businesses and is collected and put through a series of treatment and purification steps such that it meets all drinking water standards and can be added to water supplies ultimately used for drinking water. The treatment includes membrane filtration with microfiltration or ultrafiltration, reverse osmosis, and advanced oxidation that consists of disinfection with ultraviolet light and hydrogen peroxide. Purified water may be released into a groundwater basin or surface water reservoir that supplies water to a drinking water treatment facility.
Raw water	Water that has not been treated for use. Examples of raw water are water in the Colorado River aqueduct, the State Water Project aqueduct, open reservoirs (whether filled with imported water or runoff), rivers, naturally-occurring lakes and some well water.
Recycled water	Water that originated from homes and businesses as municipal wastewater and has undergone a high degree of treatment at a water reclamation facility so that it can be beneficially reused for a variety of purposes. This is the type of water that is produced at North City and is the source water for the AWP Facility.
Reservoir augmentation	The process of adding purified water to a surface water reservoir. The purified water undergoes advanced treatment prior to being blended with untreated water in a reservoir. The blended water is then treated and disinfected at a conventional drinking water treatment plant and is distributed into the drinking water delivery system.
Reverse osmosis	A high-pressure membrane filtration process that forces water through the molecular structure of several sheets of thin plastic membranes to filter out minerals and contaminants, including salts, viruses, pesticides, and other materials. The reverse osmosis membranes are like microscopic strainers; bacteria and viruses as well as inorganic and most organic molecules cannot pass through the membranes. Reverse osmosis membranes have a smaller pore size than all other types of membranes.
Retention time	The amount of time that purified water is retained in a water body such as a groundwater basin or surface water reservoir prior to being extracted.
Secondary drinking water standards	Drinking water quality standards that are not enforced, but serve as guidelines to assist public water systems in managing drinking water aesthetic conditions such as taste, color and odor.

Source control	Programs and/or processes in place to provide regulatory oversight of sewer discharges in order to protect the pipeline system and the wastewater treatment plant from harmful discharges. Source control programs typically focus on industrial and commercial (non-residential) customers and may include a variety of activities such as permitting, sampling, enforcement and oversight related to industrial discharges. For projects where purified water would enter the drinking water system via groundwater or surface water augmentation, the California Department of Public Health requires that source control programs be augmented to address residential and commercial facilities, and focus on an expanded set of contaminants that may have public health relevance, such as industrial chemicals, pharmaceuticals, and personal care product residuals sometimes found in wastewater.
Stratification	The formation of layers of water within a reservoir. This is a natural phenomenon that occurs in all reservoirs in North America. During the period of stratification, warm water that is naturally heated by the sun is contained within the top-most layer, or epilimnion, and denser cooler water is contained within the lower layer, or hypolimnion.
Tertiary treatment	Treatment of wastewater to a level beyond secondary treatment but less than water purification. Water treated to this level is considered to be recycled water, which is suitable for many beneficial uses including irrigation and industrial processes. Tertiary water meets treatment and reliability criteria established by Title 22, Chapter 4, of the California Code of Regulations.
Total organic carbon (TOC)	Total organic carbon is a measure of the amount of carbon that is bound in organic molecules, including all natural and man-made organic chemicals.
Ultrafiltration	A membrane filtration process with pore size openings smaller than microfiltration and larger than nanofiltration or reverse osmosis. Also used to characterize the size of particles removed.
Ultraviolet disinfection/advanced oxidation	Process by which water is exposed to ultraviolet light to provide disinfection, similar to the process for disinfecting instruments in medical and dental offices. Additionally, ultraviolet light combined with hydrogen peroxide creates an advanced oxidation reaction that eliminates any remaining compounds in water by breaking them down into harmless compounds.
United States Environmental Protection Agency (EPA)	The federal agency responsible for protecting public and environmental health in the United States. Its functions include developing and enforcing water quality standards for drinking water as well as man-made and naturally-occurring waters of the United States.

Wastewater	Untreated water collected in the sewer system from residences and businesses (e.g., from bathtubs, showers, bathroom sinks, clothes washers, toilets, kitchen sinks, dishwashers, and industrial processes). Wastewater is more than 99 percent water with impurities.
Wastewater collection system (collection system)	System that conveys wastewater from residences and businesses to a wastewater treatment plant such as North City.
Water Purification Demonstration Project (Demonstration Project)	The second phase of the City of San Diego's Water Reuse Program. During this test phase, the Advanced Water Purification Facility was operated for approximately one year to collect operating data, producing one million gallons of purified water per day. The Advanced Water Purification Facility remains online. A study of San Vicente Reservoir was conducted to test the key functions of reservoir augmentation and to determine the viability of a full-scale project. No purified water was sent to San Vicente Reservoir during the demonstration phase.
Water purification process	The process of using water purification technology on recycled water to produce a water supply that can be used for reservoir augmentation and ultimately for drinking water purposes. The process of water purification begins with recycled water, which has already been treated to produce a supply of water safe enough for use in irrigation and industrial purposes. This recycled water is then further treated using water purification technology. The resulting purified water can be used to augment local surface water supplies, which would be treated once more at a drinking water treatment plant to produce drinking water.
Water Quality Control Plan for the San Diego Basin (Basin Plan)	This plan establishes water quality objectives and implementation plans to protect different beneficial uses that are established for specific water bodies in the San Diego Regional Water Quality Control Board region (see beneficial use).
Water Reuse Program	The City's three-phased program, which is a potential local option to increase water supply reliability through the beneficial reuse of water.

Using This Report

This Project Report provides an overview of the technical studies, advanced water purification facility testing, and public education and outreach efforts conducted as part of the City of San Diego's Water Purification Demonstration Project. It also presents findings that support the conclusion that implementation of a reservoir augmentation project at San Vicente Reservoir is feasible.

This Project Report presents background information, key findings for each of the core components of the Demonstration Project, and considerations for full-scale project implementation. It is organized as shown in the following table.

Section A | Introduction and Summary of Findings
Section B | Advanced Water Purification Facility
Section C | San Vicente Reservoir Study
Section D | Regulatory Coordination
Section E | Public Outreach and Education
Section F | Full-Scale Project Considerations
Section G | Summary and Conclusions

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